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REVIEW ARTICLE

TIGER NUT: AS A PLANT, ITS DERIVATIVES AND BENEFITS

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ABSTRACT

Tiger nut (*Cyperus esculentus var. sativa*) as a plant, its derivatives/uses and benefits are mainly discussed. The hunt for lesser known and un-exploited crops, many of which are potentially valuable as human and animal foods has been on the high side now to retain the equilibrium between population growth and agricultural productivity, particularly in the tropical and sub-tropical areas of the world. Tiger nut is an underutilized crop of the family *Cyperaceae,* which produces rhizomes from the base and tubers that are somewhat spherical. Pollination is by wind. Young tubers are white, while older tubers are covered by a yellow outer membrane; they are usually found within six inches of the ground surface. Vegetative colonies of its plants are often produced from the tubers and their rhizomes. They are usually preserved by sun drying for about three months before storage. It can be eaten raw, dried, roasted, or grated and can be subjected to further processing. Its uses in cooking and as fuel, baking flour, fish baits; milk in lieu of cow's milk are outlined. Regarding the plant high percentage of carbohydrates (mono- and di-), fibre, and oil (especially oleic acid) and its moderately high level of protein, minerals (calcium, magnesium, iron and phosphorous), and vitamins C and E makes it a good source of food for humans and animals. It is a cheap source of nutrition for both the rich and the poor. The health benefits reflect reduction of low density lipoprotein-cholesterol, which is good for sports' men and women and those intending to lose weight; it is also said to serve as a cure for flatulence and diarrhea, and as control against heart attacks, thrombosis and colon cancer, among others. The presence of anti-nutrients like polyphenols and tannins can be eliminated by boiling in water. The tiger nut, though under-utilized, is still a good food snack for all. There is a need for awareness creation on tiger nut's inherent nutritional properties.

Key words: nut, nutrition, tuber, health, benefit

INTRODUCTION

Tiger nut (*Cyperus esculentus var. sativus)*, an emergent grass- like plant belonging to the sedge family, is also found to be a cosmopolitan perennial crop of the same genus as the papyrus plant that is common in seasonally flooded wetlands [1, 2]. It is widely distributed in the temperature zones within South Europe as its probable origin, and has become naturalized in Ghana, Nigeria and Sierra Leone [3]. Tiger nut is one of the earliest domesticated crops and in fact, was found in vases and was used to embalm bodies of the Egyptian Pharaohs [4]. In Nigeria, tiger nut is available in fresh, semi-dried and dried form in the markets where it is sold locally and consumed even uncooked. Tiger nuts are under-utilized due to lack of information on their nutritional potential [5]. A lot of people eat the tiger nut without knowing the nutritional benefits and products that can be obtained from it like tiger nut oil and milk. The purpose of this review was to bring together some of the data on the uses, health and economic benefits of the tuber of the tiger nut that is completely unexploited in Nigeria.

Tiger nut as a plant

Tiger nut is a tough erect fibrous-rooted perennial plant, 1 to 3 ft high, reproducing by seeds and by many deep, slender rhizomes, which form weak runners above the ground, and small tubers or nutlets at the tips of underground stems [6]. This native perennial sedge is ½–2 inches tall and unbranched. The central stem is erect, 3-angled, and mostly covered by the sheaths of the leaves. The leaves tend to congregate toward the base of the plant. The leaf blades are up to 1½ inches long and 1/3 inches across; they are light green and glabrous, spreading outward from the stem. There is a conspicuous channel along the central vein of each leaf blade, especially the larger ones. The leaf sheaths are whitish green, closed, and hairless; sometimes they become pale red towards the base of the plant [7]. The central stem terminates in an umbel or compound umbel of floral spikes; the size and shape of the umbel is rather variable (on larger plants, it is usually several inches across). Each umbel has 1-3 sessile spikes and 6-10 non-sessile spikes on straight branches of varying length. At the base of each umbel or compound umbel of spikelets, there are several leafy bracts of varying length; the largest bract is usually longer than the inflorescence. Each floral spike is about 2-3 inches long, consisting of 4 ranks of spikelets along its central stalk (or rachis). The central stalk is flattened and narrowly winged. The spikelets are perpendicular to this stalk and about ½–¾ inches long. The spikelets are yellow to golden brown, narrowly linear, and flattened in shape; they consist of 10-30 florets and their scales. The overlapping scales are slightly spreading along the length of each spikelet; each scale is 2.0–3.0 mm. in length. Each floret has a white tripartite style and yellowish brown anthers; the tips of the styles are curly. The blooming period occurs from mid-summer to early fall.

Pollination of the tiger nut plant is by wind [8]. The florets are replaced by small achenes that are 1.0–1.5 mm. long, oblongoid or oblongoid-obovoid, and flattened. The shallow root system is fibrous, rhizomatous, and tuberous. The white rhizomes have a slightly segmented appearance from the brown margins of their outer membranes; the rhizomes are connected to small globoid tubers up to ½ inch across. Young tubers are white, while older tubers are covered by a yellow outer membrane;

they are usually found within 6 inches of the ground surface. Vegetative colonies of plants are often produced from the tubers and their rhizomes. The nutlets are almost smooth at maturity and unevenly globe shaped [8]. High temperatures and low nitrogen levels increase tuber production and an increased day length (by lighting) will reduce tuber formation. The tuber epidermis (skin) contains substances, which inhibit sprouting of tubers; the plant grows best in moist sandy-loam soils but will grow in the hardest clay, tolerates high soil moisture and is intolerant to shade [8, 9]. The plant produces small, oblong tubers in abundance, which are sweet and rich in fat [10].

It has many other names like Zulu nut, yellow nutgrass, ground almond, chufa, edible rush and rush nut [11]**.** In Nigeria, the Hausas call it "Aya", Yorubas "imumu", the igbos "ofio", "aki Hausa" in southern Nigeria [12]. Tiger nuts which are incorrectly called "nuts" or "nutlets," thus the origin of their common name, are small about the size of a peanut growing at the rhizome of the plant [13]. Like other sedges, the plant is most frequently found inhabiting wet marshes and edges of streams and ponds where it grows in coarse tufts [14]. Tiger nut tubers are daily ingredients of the diet of many people in North Africa and Spain [15]. In North Africa, the tubers are consumed in their natural form or after being soaked in water for some hours. In Spain, the tubers are consumed mainly as a drink called locally "horchata de chufa" (chufa milk). This plant was originally native to the Mediterranean region but its cultivation has now spread to many warm countries [16]. It is usually sown in April and picked in November [17]. There are mainly three varieties namely**:** black, brown and yellow, and only yellow and brown are readily available in the Nigerian markets. The yellow variety is preferred to all other varieties because of its inherent properties like its bigger size, attractive colour and fleshier body. The yellow variety also yields more milk, contains lower fat and higher protein and less anti-nutritional factors especially polyphenols [18].

Figure 1: Fresh tiger nut [13]

In Northern Nigeria, the nut can be bought in the market all year round. The weight of fresh tuber ranges from 70mg to about 900mg while the weight of dried tuber ranges from 30mg to 350mg. A dried tuber nut can absorb up to three times its own weight of water. A single tuber can produce nearly 2000 plants and 7000 tubers in one growing

season. It was observed that tiger nut production is predominantly the work of women farmers as high as 70% and 30% men [13]. The nuts are valued for their highly nutritious starch content, dietary fibre, digestible carbohydrate (mono, di and polysaccharides) [14, 19]. The nut was reported to be rich in sucrose (17.4 to 20.0%) and fat (25.50%) which are resistant to peroxidation, and protein (7-8%) [9, 20, 21] as indicated in Table 1. The nut is also fairly rich in mineral content (Sodium, Calcium, Potassium Magnesium, Zinc and traces of Copper) [22]. Tiger nut has been cultivated as a livestock food and for human consumption; it can be eaten raw, roasted, grated, baked or used for ice cream and beverage making for its many useful benefits [22, 23]. They taste best when dried. They are generally dried out (mostly in the sun), a process that takes one or more months with occasional turning over to ensure uniform drying to preserve them and to eliminate prevailing rot or any microbial infection. This secures their nutritional quality although, unfortunately, as they dry, they become wrinkled. As they dry, temperature and relative humidity are monitored. Once dry, they can be kept for several years, to be reconstituted by soaking overnight or by boiling when ready to serve them [23]. The nutritional value of tiger nut derivatives, like oil and milk, arises from the very composition of the tiger nut. The level of anti-nutrients such as tannins, alkaloids and polyphenols is drastically reduced by soaking in water for 6 hours, thereby making it free of unwanted elements especially in making the milk [24].

Tiger nut milk

The origin of the use of this tuber for making milk is exclusive to the Spaniards to which it may have been introduced by the Arabs. Tiger nut milk/beverage/drink commonly called '*kunnu aya*' in northern Nigeria is a healthy drink with many nutrients. It is a nourishing and energetic product recommended by experts to be taken during any season of the year, especially in dry season when the sun is hot. In Spain, it is called *chufa de horchata*. It is a rich source of nutrients such as vitamins C and E, and minerals such as phosphorus, magnesium, potassium, calcium, iron, and also carbohydrates, unsaturated fats, proteins and some enzymes which help in digestion [25]. In fact this drink contains more iron, magnesium and carbohydrates than the cow's milk [26]. It has also the advantage of not containing lactose, casein, sugar or proteins of the milk, or cholesterol and is therefore an ideal drink for people who do not tolerate gluten or cow's milk [23]. The nutritional value of tiger nut beverage is, however, insufficient given that its protein content is low (6.05%) [25, 27]. The production process for tiger nut milk is shown in figure 1.

Purchase and sort dry tiger nuts

↓

Wash and soak in water for 8 hours

↓

Grind in a ratio of 3 litres of water for each kilogram of tiger nuts and the mixture is left to macerate for 10minutes.

↓

Press and sift

↓

Sugar, cinnamon, and lemon are added to taste

↓

Serve chilled or in Package

Figure 2: Flow chart of Production process of tiger nut milk [25]

Tiger nut flour

Tiger nut flour has a unique sweet taste, which is ideal for different uses. It is a good alternative to many other flours like wheat flour, as it is gluten free and good for people who cannot take gluten in their diets. It is also used in the confectionery industry [23, 28]. It is considered good flour or additive for the bakery industry, as its natural sugar content is fairly high, avoiding the necessity of adding too much extra sugar [29]. Also, it can be used as a flavoring agent for ice cream and biscuits [30]. In the Keta area of Ghana, the sun-dried tubers are ground to a fine powder to which sugar can be added to be stored till required. Roasted tubers may be similarly ground to a powder known in Vhe (Awlan) as fie-dzowe. These meals may be eaten alone or with water added to make a beverage [31]. In addition, tiger nut has been demonstrated to contain higher essential amino acids than those proposed in the protein standard by the FAO/WHO [28] for satisfying adult needs. Therefore, tiger nut, with its inherent nutritional and therapeutic advantage, could serve as good alternative to cassava in the baking industry [32].

Furthermore, tiger nut flour does not lose any of its nutritious properties in the milling process. The fine ground tiger nut flour gives baits a smooth, creamy texture with a distinctive taste fish love, and can be incorporated into any mix as base ingredient, allowing baits to retain moisture [33]. Incidentally, cutting part or all of the skins off tiger nut hook baits makes them more effective. Part of tiger nuts' attraction is that they are rich in lysine, a major fish feeding stimulant though tiger nuts also contain many other extremely important and stimulatory dietary essential amino acids for fish, including methionine, cystine, arginine and histidine [34, 35]. The production process for tiger nut flour is shown in figure 2.

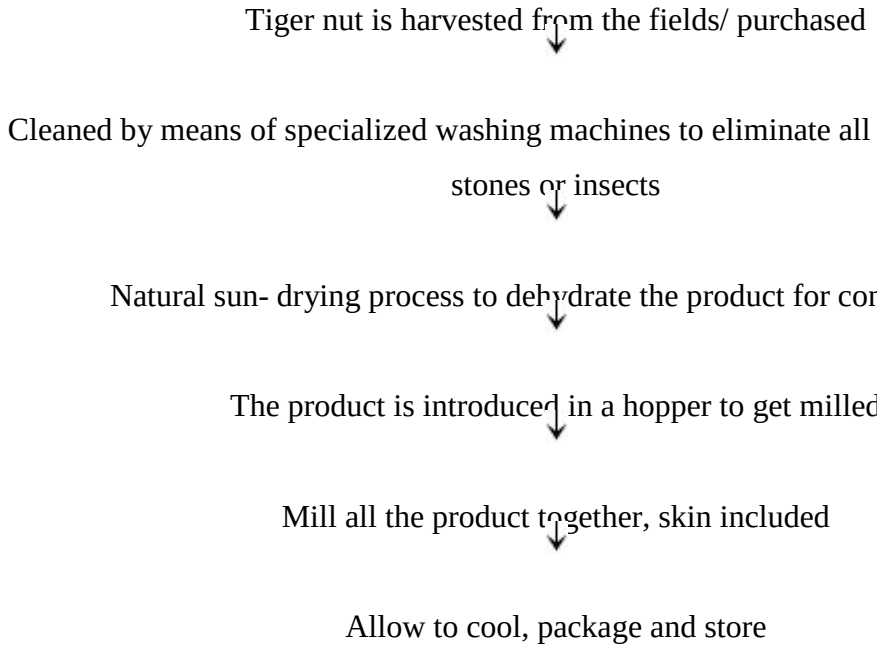

Figure 3: Flow chart of production process of tiger nut flour [25].

Tiger nut oil

The edible and stable oil obtained from the tuber is said to be superior oil that compares favourably with olive oil. The oil is golden brown in colour and has a rich, nutty taste [17]. The oil remains in a uniform liquid form at refrigeration temperature. This makes the oil suitable for salad making. It has a high oleic acid and low polyunsaturated fatty acid (linoleic acid and linolenic acid) [36, 37], enough to cover daily minimum needs for an adult (around 10 g) and low acidity, and so is excellent for the skin. It also has higher oxidative stability than other oils, due to the presence of polyunsaturated fatty acids and gamma-tocoferol [37]. It is regarded as high quality oil due to its extraction without adding any external heat (cold pressed oil), and is highly recommended for cooking over other oils because it is more resistant to chemical decomposition at high temperatures [38]. Furthermore, less fat is absorbed into the food as it creates a crust on the surface during cooking, preventing the oil itself being absorbed into the product. In the textile industry, the oil is used to waterproof textile fibres. The oil compares well with corn, soybean, olive and cotton seed oil and can thus serve as a substitute for these oils especially in times of scarcity [39]. The oil is a potential source of biodiesel and much research has been conducted [40]. The production process for tiger nut oil is shown in figure 3.

Harvest

↓

The nuts are harvested from farm, they are sorted and washed to remove foreign matter.

↓

They are dried to safe moisture content (8%) (The drying is critical to having quality oil)

↓

The nuts are milled into flour with a mechanized grinder

↓

The flour is put into a press which squeeze the flour thereby extracting the oil slowly by sweating in a first cold extraction of the oil

↓

The extracted oil is filtered to remove impurities

↓

The purified oil is collected in barrels

Figure 4: Flow chart of Production process of tiger nut oil (cold press extraction) [25]

Economics and Nutritional benefits of tiger nut

According to Mason [13], tiger nuts have long been recognized for their health benefits as they have a high content of soluble glucose and oleic acid, along with high energy content (starch, fats, sugars and proteins), they are rich in minerals such as phosphorous and potassium, calcium, magnesium and iron necessary for bones, tissue repair, muscles, the blood stream and for body growth and development and rich in vitamins E and C. Sugar-free tiger nut milk is suitable for diabetic people and also helps in weight control [41], due to its content of carbohydrates with a base of sucrose and starch (without glucose), and its high content of Arginine, which liberates the hormone that produces insulin [25,42]. It is recommended for those who suffer from indigestion, flatulence and diarrhoea because it provides digestive enzymes like the catalase, lipase and amylase. The high content of oleic acid has positive effect on cholesterol, thereby preventing heart attacks, thrombosis and activates blood content of soluble glucose. Tiger nut reduces the risk of colon cancer. It prevents constipation. Tiger nut contains a good quantity of vitamin B1, which assists in balancing the central nervous system and helps to encourage the body to adapt to stress [25, 43]. The milk supplies the body with enough quantity of Vitamin E, essential for fertility in both men and women. Vitamin E also delays cell aging, improves elasticity of skin and helps to clear the appearance of wrinkles, acne and other skin alterations.

In China, tiger nut milk is used as a liver tonic, heart stimulant, drank to heal serious stomach pain, to promote normal menstruation, to heal mouth and gum ulcers, used in

Ayurvedic medicines and is a powerful aphrodisiac (sexual stimulant). The black species of the tiger nut is an excellent medicine for breast lumps and cancer. The tubers have a relatively high total antioxidant capacity, because they contain considerable amounts of water-soluble flavonoid glycosides. Consumption of antioxidants could protect the immune system of malnourished populations. The intake of antioxidant-containing foods may delay the progression of HIV infection to AIDS [44].

For many years, the tiger nut tubers have been considered to have adequate properties to fight respiratory infections, and some stomach illnesses. To this date, the *Horchata de chufa* is considered an effective remedy for diarrhea, according to popular tradition in Valencia, Spain. It promotes the production of urine and this is why it is a preventive measure for cyst, prostrate, hernia, rectum deformation and prolapsed (anal feature-small painful flesh at the tip of the anus) and to prevent endometriosis or fibrosis as well as blockage of the tip of the fallopian tube. The oil reduces low density lipoprotein-cholesterol (LDL-C) and increases high density lipoprotein-cholesterol (HDL-C) [23], reduces levels of triglycerides in blood and the risk of forming bloody clots, thereby preventing arteriosclerosis. It also stimulates the absorption of calcium in bones and the production of new bony material, due to short and medium chain fatty acids, oleic acid and essential fatty acids [14]. It is also recommended for infants and the elderly because of its high content in Vitamin E and its antioxidant benefits in the cell membrane [43].

In the United States, the primary use of tiger nut as a crop is to attract and feed game, particularly wild turkeys. Turkeys love tiger nut tubers; as natural scratchers, once discovering a plot of chufa, they will return again and again, all winter long, or until spring arrives and other food is readily available [25]. Tiger nut tubers have been planted so that pigs could be attracted to the fields to fatten and improve the taste of pork. The tubers have been used as hog feed, pastured in the field in states such as Florida, Georgia, and Alabama. Tubers of tiger nut have also been identified as valuable food for waterfowl and cranes. Ducks dive for them when wetland fields are flooded. It is also used in seed mixes for wetland restoration, mitigation, and erosion control. The caramel from malted tubers of *Cyperus esculentus* may be used to add body, flavor, or color to certain baked products, non-alcoholic malt beverages and dark beers, and in the production of condiments. The starches obtained from tiger nut and rice showed similar properties; the solutions of the starch exhibited a good paste stability, clarity, and adhesive strength. The starch can be used in many starch-based foods as well as in the cosmetic industry, and for laundry, glazing and stiffening. The waste residue after oil extraction could be further modified to produce syrups, flours, or livestock feeds [27, 44].

CONCLUSION

Although tiger nut is largely unexploited, cheap and eaten without much knowledge of its benefits, there is an urgent need for awareness campaigns on its health and nutritional benefits.

Table 1: Proximate composition of Tiger nut tuber

Parameter	Dry matter (%)
Moisture (%wet wt)	5.77
Crude protein	7.00
Ether extract	25.70
Total ash	1.86
Crude fibre	5.50
NFE	60.00
Total carbohydrate	65.50
Caloric value (kcal)	524.6

Source: Oderinde and Tahir [9]

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